

**Validation of *Eleutherodactylus crepitans* Bokermann, 1965, notes on the types and type locality of *Telatrema heterodactylum* Miranda-Ribeiro, 1937, and description of a new species of *Eleutherodactylus* from Mato Grosso, Brazil (Amphibia: Anura: Leptodactylidae)**

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*Abstract.*—Examination of the types of *Eleutherodactylus crepitans* Bokermann, 1965, indicates that they represent a valid species, which should be removed from the synonymy of *Eleutherodactylus fenestratus* (Steindachner 1864). *Eleutherodactylus crepitans* is only known from the type material. Certain features of the types of *Telatrema heterodactylum* Miranda-Ribeiro, 1937, are described and the type locality clarified. Analysis of the advertisement call and morphology of a series of specimens from Chapada dos Guimarães indicates that the specimens represent a species distinct from *E. fenestratus* (Steindachner 1864), for which no name is available. We describe this new species as *Eleutherodactylus dundeei*. The frog fauna of Chapada dos Guimarães contains four distinct historical units: cerrado, chaco, Amazonian hylaea, and endemic.

The advertisement call of what has been identified as *Eleutherodactylus fenestratus* from Chapada dos Guimarães, Mato Grosso, Brazil, was recently recorded by WRH as part of PRODEAGRO. PRODEAGRO is an ecological-agricultural survey of the State of Mato Grosso, undertaken by the State Secretariat of Planning, funded by the World Bank, and contracted to the São Paulo firm of consultants “Consortio Nacional de Engenheiros Consultores” (CENEC). As part of the National Museum of Natural History’s Research Training Program, AMM analyzed the advertisement call of the Chapada dos Guimarães form and compared it to the advertisement call of *Eleutherodactylus fenestratus* from the Amazon basin. The results indicate that the Chapada dos Guimarães form is a different species from the Amazonian *E. fenestratus*. To determine whether there is an available name for the Chapada dos Guimarães form and

whether it has a distribution beyond the region of the town of Chapada dos Guimarães, we examined other specimens of *Eleutherodactylus* from Mato Grosso, including the type material of *Telatrema heterodactylum* Miranda-Ribeiro, 1937 and *Eleutherodactylus crepitans* Bokermann, 1965. The purpose of this paper is to report our findings.

#### Methods and Materials

The first recording of the Chapada dos Guimarães form is from USNM Tape 320, Cut 2, Brazil, Mato Grosso, Chapada dos Guimarães, Estancia Monarca, recorded 30 September 1996, between 1835–1930 h, air temperature 21.6°C, unvouchered, by WRH, one call recorded and analyzed. The second recording of the Chapada dos Guimarães form is from USNM Tape 320, Cut 3, same data as Cut 2, except recorded at

1930 h, voucher USNM 507899, one call recorded and analyzed. The recordings for *Eleutherodactylus fenestratus* are from USNM Tape 206, Cut 2, Peru, Madre de Dios, Tambopata, recorded 6 January 1989, 1850 h, air temperature 24.0°C, voucher USNM 342993, by Reginald B. Cocroft III, four calls analyzed, and USNM Tape 266, Cut 19, Peru, Madre de Dios, Tambopata, recorded 15 November 1990, 1815 h, air temperature 27.0°C, unvouchered, by Reginald B. Cocroft III, six calls analyzed.

Call recordings were digitized using Sound Image software at a sampling frequency of 22.05 KHz and 16-bit resolution. The digitized calls were converted into audio data files using a wave converter package and analyzed as audiospectrograms and wave forms using Computerized Speech Research Environment software (AVAAZ Innovations Inc., Version 4.2).

Eleven parameters were analyzed for each call following the definitions of Heyer et al. (1990): call duration, call rate, notes per call, note duration, note repetition, note pulsation, fundamental frequency, dominant frequency, change in dominant frequency, peak frequency, and characterization of harmonics.

The audiospectrograms used in Fig. 1 were produced using Canary software (Cornell Laboratory of Ornithology, Version 1.2).

Color pattern and external morphological data were recorded using a system of sketches to represent all distinctive patterns or states. These data were then summarized and categorized into written character states. Measurements were taken with dial calipers and recorded to the nearest 0.1 mm following Heyer (1984). Adult males were determined by presence of vocal slits. Adult females were determined by presence of mature ova visible through the body wall. Unclear sex determinations based on external examination were verified by dissection. Multivariate discriminant function analyses were performed using SYSTAT 7.0 for Windows.

Specimens examined are listed in Appendix 1. Museum abbreviations follow Leviton et al. (1985).

## Results

*Advertisement calls.*—The ideal calls to compare the Chapada dos Guimarães form with are those from topotypic *Eleutherodactylus fenestratus* males. *Eleutherodactylus fenestratus* (Steindachner 1864) was described from specimens from Rio Marmoré, Rondônia and Borba, Amazonas, Brazil. The geographically most proximate adequate recordings we know for Amazonian *E. fenestratus* are from Tambopata, Peru. We use these recordings to represent *E. fenestratus* for our comparisons.

As there is some variation among the four individual frogs recorded from Peru and Brazil, the data are summarized by individual caller (Table 1).

The frog from Tambopata, USNM Tape 206, Cut 2, has a mean call duration of 0.31 sec; 2.75 mean notes per call; and a mean note duration of 0.07 sec. The dominant frequency is the second harmonic; additional harmonics are present, but weak. (Fig. 1a).

The second frog from Tambopata, USNM Tape 266, Cut 19, has a mean call duration of 0.18 sec; and a mean note duration of 0.07 sec. The dominant frequency is the second harmonic; additional harmonics are present, but weak.

The single call of the frog from Chapada dos Guimarães, USNM Tape 320, Cut 2, has a relatively short (0.02 sec) and weak first note, the other 4 notes are stronger and have a duration range of 0.03–0.04 sec. The notes are pulsatile. The dominant frequency is the second harmonic; additional harmonics are present, but weak.

The single call of the second frog from Chapada dos Guimarães, USNM Tape 320, Cut 3, has a relatively short (0.02 sec) and weak first note, all other notes are stronger with a duration of 0.04–0.05 sec. The notes are pulsatile. The dominant frequency is the



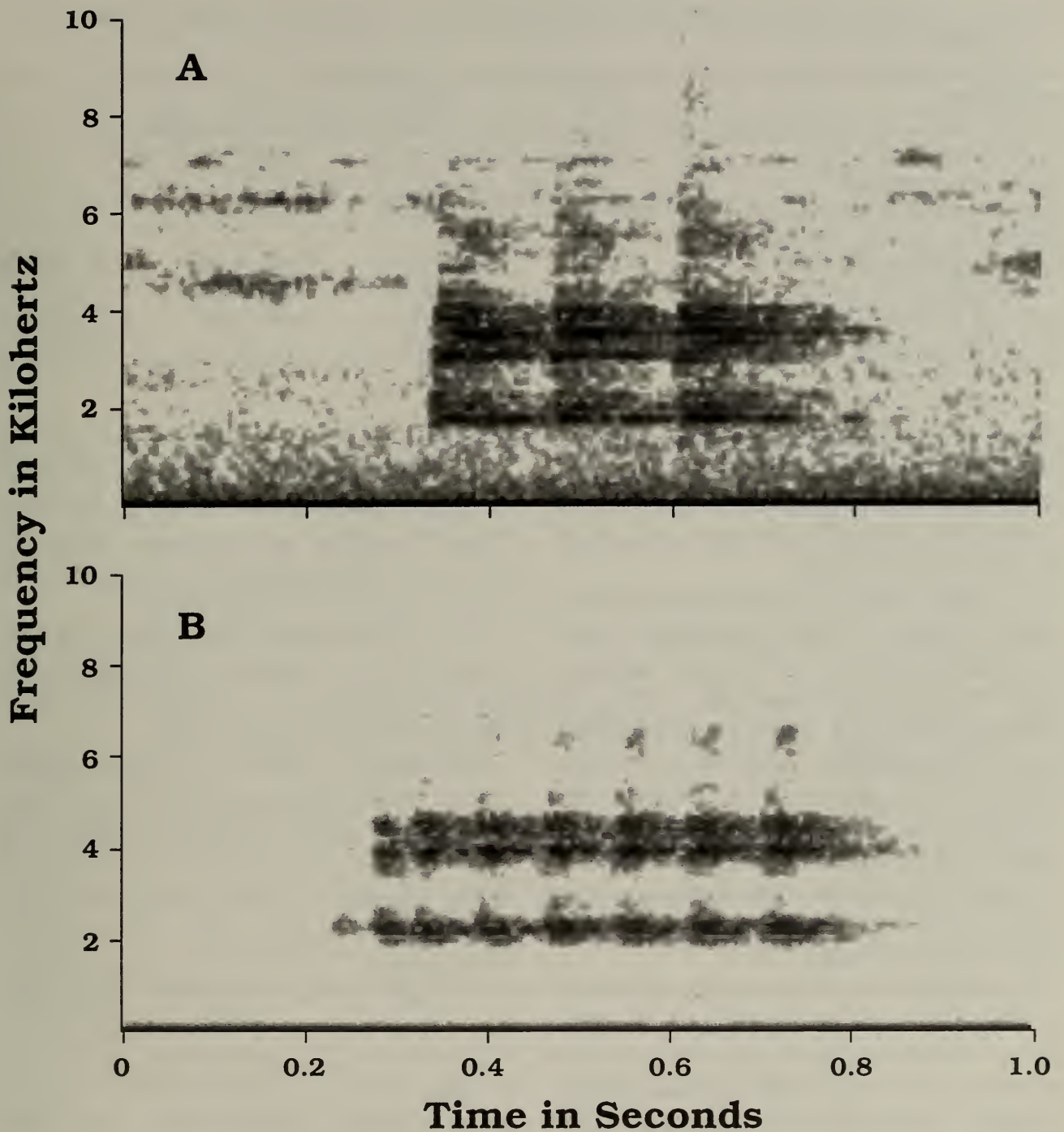


Fig. 1. A. Advertisement call of *Eleutherodactylus fenestratus*, USNM Tape 206, Cut 2. B. Advertisement call of Chapada dos Guimarães form, USNM Tape 320, Cut 3.

second harmonic; additional harmonics are present, but weak. (Fig. 1b).

There is some variation between individual male vocalizations from the same locality. The variation observed between the recordings from Tambopata might be accounted for by differences of temperature of calling males, at least in part. As a general rule for frogs, increases in temperature result in decreased call and note duration

and increased note repetition rate (Schneider et al. 1984; Duellman & Trueb 1986). The three degree difference of ambient temperature between the two recordings of the Peruvian specimens is in the predicted direction for call and note duration and note repetition rate. Note, however, that the recordings from Chapada dos Guimarães were recorded at lower temperatures than those of Peru, yet these Brazilian calls had

Table 1.—Advertisement call data for four *Eleutherodactylus* specimens from Tambopata, Peru and Chapada dos Guimarães, Brazil.

Geographic area USNM Tape and Cut	Peru 206, 2	Peru 266, 19	Brazil 320, 2	Brazil 320, 3
Call duration (sec)	0.21–0.36	0.16–0.20	0.29	0.53
Number of notes/call	2–3	2	5	8
Note duration (sec)	0.06–0.09	0.05–0.08	0.04	0.05
(Mean) note repetition rate per sec	7.6	9.1	14.7	13.7
Fundamental frequency range	1636–2411	1464–2497	1894–2239	1808–2497
Peak fundamental frequency	1720	2067	2067	2153
Dominant frequency range	2842–4392	2842–4220	3014–4220	3273–4737
Peak dominant frequency	3531	3617	3692	3875

shorter note durations and higher note repetition rates than the Peruvian calls, indicating that temperature differences do not explain the differences between the Brazilian and Peruvian calls.

The calls from Brazil and Peru do not differ in terms of carrier frequencies; they are broadcasting in the same frequency band. The calls differ markedly in terms of temporal packaging (Table 1), such as number of notes per call, individual note duration, and note repetition rate. Penna (1997) among others, has experimentally demonstrated that the kinds of temporal differences found between the Tambopata and Chapada dos Guimarães frogs are recognized as species differences by frogs.

Unfortunately, to date, there are no recordings of what we consider to be Amazonian *Eleutherodactylus fenestratus* from the hylaea of northern Mato Grosso. In fact, the only other published recordings for *E. fenestratus* are from Amazonian Bolivia (Marquez et al. 1995) and are very similar to the recordings from Tambopata. Ronald I. Crombie made three recordings in Rondônia, Brazil in which a single call of an *E. fenestratus* is in the background. In two of them (USNM Tape 55, Cut 5 and USNM Tape 56, Cut 5, both from Alto Paraiso), the call sounds as though it consists of two notes, but can not be confirmed on an audiospectrogram due to the relative weakness of the call and strength of the background noise. The call on USNM Tape 56, Cut 8 from Santa Cruz da Serra is a bit

stronger and the audiospectrogram indicates it is comprised of two notes at a dominant broadcast frequency of 3300 Hz. The calls from Rondônia, as expected, match the calls from Tambopata rather than the calls from Chapada dos Guimarães.

The advertisement call evidence is consistent with recognizing the Chapada dos Guimarães form as a species distinct from *Eleutherodactylus fenestratus*.

*Morphology*.—There are two available names for *Eleutherodactylus* from Mato Grosso that potentially could apply to the Chapada dos Guimarães form. There are also a number of *Eleutherodactylus fenestratus*-like specimens from Mato Grosso. The purpose of this section is to compare the Chapada dos Guimarães form with these specimens to determine whether the Chapada dos Guimarães form occurs more broadly within the State of Mato Grosso and to determine whether there is an available name for it.

The materials for comparison comprise the following (Fig. 2 for Mato Grosso localities; Appendix 1 for specimen lists): the 2 types of *Telatrema heterodactylum* Miranda-Ribeiro, 1937; the 3 type specimens of *Eleutherodactylus crepitans* Bokermann, 1965; 11 specimens from Chapada dos Guimarães; 2 specimens from Fazenda Santa Edwiges; 1 specimen from Jacubim; 2 specimens from Barra do Tapirapés; and specimens considered to be *E. fenestratus*; 3 specimens from São Jose do Rio Claro; 8 specimens from Apiacás, 48 specimens



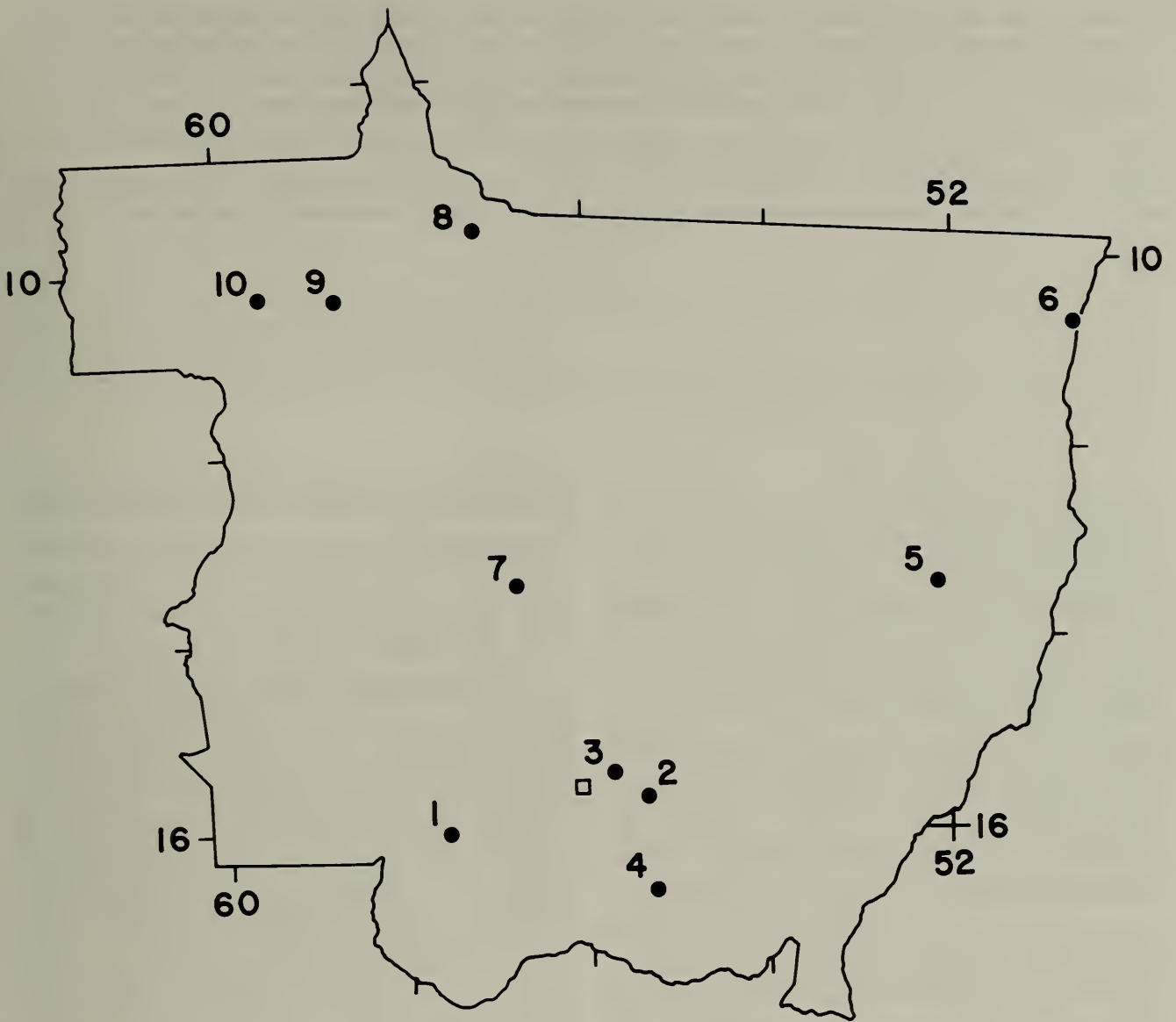


Fig. 2. Outline map of the State of Mato Grosso. See text for key to locality numbers. Open square is the city of Cuiabá.

from Juruena (measurement data taken for 10 females and 1 male), 1 specimen from Alto Juruena, 46 specimens from Aripuanã (measurement data taken for 10 males and females), and 28 specimens from Tambopata and Pakitza, Madre de Dios, Peru (the specimens from the nearby locality of Pakitza were added to those from Tambopata to bring the sample sizes up to at least 10 males and 10 females).

Patterns: The dorsal snout patterns demonstrate as much intra- as inter-population variation and are not discussed further. The other patterns analyzed demonstrate some levels of interpopulation variation (Tables 2–8). In some cases, the sample sizes are

adequate to conclude that the variation is meaningful (e.g., the differences in loreal region pattern between the Mato Grosso populations of *Eleutherodactylus fenestratus* (Table 3, samples 7–10) and the Peruvian sample of *E. fenestratus*. In other cases, the differences are suggestive, but any conclusions are compromised by sample sizes. For example, there are two aspects of light mid-dorsal stripes that are impacted by small sample size. The first is that there is variation in the presence condition of the stripe. It may either be narrow or broad, and it may extend from the tip of the snout to the vent or from the interocular area to the vent. Because there were relatively few in-

Table 2.—Interorbital markings. Locality numbers refer to those in Fig. 2 (9a not mappable). A = Almost absent; B = Outlined only, not with expansion; C = Solid, not with expansion; D = Solid with single prominent posterior expansion; E = Solid with bifid prominent posterior expansion. Data are number of individuals demonstrating the various states (question mark indicates specimen faded, state uncertain).

Taxa Locality	<i>E. heterodactylus</i> 1	<i>E. crepitans</i> 2	C. dos Guimarães 3	?	?	?	<i>E. fenestratus</i>						
							7	8	9	9a	10	Peru	
A													5
B								2	12			9	2
C	1 <sup>a</sup>	3	11	1	1	?	3	6	9	1	11		9
D													6
E													6

<sup>a</sup> From illustration 2a (Miranda-Ribeiro 1937).

dividuals with light mid-dorsal stripes, the information had to be collapsed for comparison. Second, the sample size for the Chapada dos Guimarães form is too small to conclude that it lacks light mid-dorsal stripes, even though all 11 specimens examined lack them. There are three adequate samples of *E. fenestratus* to compare with the Chapada dos Guimarães form: Aripuanã, Juruena, and Peru. For Aripuanã, the probability of an individual having a mid-dorsal stripe is 0.35, thus the probability of not having a stripe is 0.65. If we use that probability to ask whether the Chapada dos Guimarães population could have the same occurrence of stripes, the answer is no:  $0.65^{11} = P < 0.001$  (exact probability test). However, when the population data from Juruena and Peru are used, the answer is yes: for Juruena, the probability of not having a stripe is 0.91, for Peru 0.92, with  $P = 0.35$  and 0.40 respectively. Thus, based on the low frequency of occurrence of mid-dorsal stripes in the Juruena and Peru sam-

ples, if the Chapada dos Guimarães form has mid-dorsal stripes at those same frequencies of occurrence, then the sample size is not adequate to have found individuals with that condition.

Morphological features: All but three individuals scored for tarsal fold variation had discernible tarsal folds (Table 9). It is likely that the three individuals thus scored actually have them but are preserved in such a manner that they are not discernible. The two individuals of *Eleutherodactylus crepitans* with discernible tarsal folds have a very different morphology from all other specimens examined (Table 9). The variation in toe fringe condition is continuous (Table 10). The fringed condition is weakly fringed, with noticeable basal toe webbing (the fringe is not as well-developed as in some species of *Leptodactylus*, for example). The variation in tubercles on the sole of the foot (Table 11) suggests that *E. crepitans* is distinctive (in contrast to completely distinct) from the other samples, and

Table 3.—Loreal region patterns. Locality numbers refer to those in Fig. 2 (Locality 9a not mappable). A = No pattern; B = Incomplete stripe in front of eye; C = Dark stripe from eye to nostril, entire loreal region may be dark. Data are number of individuals exhibiting various states. Pattern not discernible for specimen from locality 6.

Taxa Locality	<i>E. heterodactylus</i> 1	<i>E. crepitans</i> 2	C. dos Guimarães 3	?	?	?	<i>E. fenestratus</i>						
							7	8	9	9a	10	Peru	
A													8
B	1	2	4		1				9	1	1		13
C		1	7	2			3	8	12		20		7



Table 4.—Supratympanic fold patterns. Locality numbers refer to those in Fig. 2 (9a not mappable). A = Fold not accentuated with dark brown band; B = Fold accentuated with interrupted dark brown band; C = Fold accentuated with solid dark brown band. Data are number of individuals demonstrating the various states (question mark indicates state uncertain due to fading or perspective of illustration).

Taxa Locality	<i>E. heterodactylus</i> 1	<i>E. crepitans</i> 2	C. dos Guimarães 3	? 4	? 5	? 6	<i>E. fenestratus</i>					Peru
							7	8	9	9a	10	
A	? <sup>a</sup>											2
B		3	2		1							12
C			9	2		?	3	8	21	1	21	14

<sup>a</sup> From illustration 2a (Miranda-Ribeiro 1937).

the variation in the Chapada dos Guimarães specimen tubercles is distinctive from the variation observed in the *E. fenestratus* samples.

Measurements: Male and female sizes vary among the samples (Table 12). Two points are worth noting, although additional samples are necessary to verify them statistically. There is no sexual size dimorphism in the *Eleutherodactylus crepitans* sample, whereas sexual size dimorphism is pronounced in all other samples that contain both sexes. The Chapada dos Guimarães form is smaller than the *Eleutherodactylus fenestratus* samples analyzed.

The results of multivariate discriminant function analyses for males and females (analyzed separately) agree in that the *Eleutherodactylus crepitans* specimens are clearly distinct from all other individuals analyzed (Fig. 3). The rest of the populations analyzed indicate that there is differentiation among them, but the degree of variation is consistent with both intra- and inter-specific variation based on similar studies in other groups of frogs.

## Taxonomy

*Telatrema heterodactylum* *Miranda-Ribeiro, 1937*.—Alipio Miranda-Ribeiro described this species from “Matto-Grosso—Caceres, 2 exemplares colhidos na gruta dita ‘Fazendinha’ Comm. Rondon (1937: 67).” His son Paulo Miranda-Ribeiro designated specimen 106A in the collection of the Museu Nacional, Rio de Janeiro, as the lectotype (1955:411). The second specimen, the paralectotype, which also had the number 106 originally, was subsequently recatalogued as 5089.

Dr. P. E. Vanzolini (pers. comm.) was able to locate A. Miranda-Ribeiro’s locality. Miranda-Ribeiro was a member of the Rondon Commission expedition and he collected the specimens in question himself. Caceres, as used by Miranda-Ribeiro, refers to the municipality, which at the time of the Rondon Commission expedition was very extensive. Vanzolini found in the Rondon Commission itinerary that Miranda-Ribeiro travelled to “Fazendinha” and returned to Caceres in the same day and that “Fazendinha” was near a place called Pirizal. Van-

Table 5.—Mid-dorsal stripe patterns. Locality numbers refer to those in Fig. 2 (9a not mappable). A = Absent; B = Present. Data are number of individuals demonstrating the states.

Taxa Locality	<i>E. heterodactylus</i> 1	<i>E. crepitans</i> 2	C. dos Guimarães 3	? 4	? 5	? 6	<i>E. fenestratus</i>					Peru
							7	8	9	9a	10	
A	1	3	11	2	1	2	3	8	44	1	34	26
B									4		12	2

Table 6.—Dorsal patterns. Locality numbers refer to those in Fig. 2 (9a not mappable). A = Indistinct or uniform; B = Dark symmetrical spots; C = Dark chevron in medial scapular region followed by dark blotches posteriorly; D = Dark W-shaped mark in medial scapular region followed by dark blotches posteriorly; E = Extended dark W-shaped pattern (additional strophes to next in series from inverted V to W) in medial scapular region followed by dark blotches posteriorly. Data are number of individuals demonstrating the various states (question mark indicates uncertain condition due to fading).

Taxa Locality	<i>E. heterodactylus</i> 1	<i>E. crepitans</i> 2	C. dos Guimarães 3	?	?	?	<i>E. fenestratus</i>					
							7	8	9	9a	10	Peru
A			2		1	?	1	3	7	1	9	13
B				2				1	3		4	
C	1 <sup>a</sup>							4	2		2	
D		1	9				2		9		6	15
E		2										

<sup>a</sup> From illustration 2a, b (Miranda-Ribeiro 1937).

zolini located a “Fazendinha” that not only meets these conditions, but is in an area known to have sandstone caves (grutas = caves) at 16°00’S, 57°36’W (Fig. 2, Locality 1).

Lynch & Duellman (1997:225) recognized *Eleutherodactylus heterodactylus* (Miranda-Ribeiro, 1937) as a distinct species and included it in the *Eleutherodactylus binotatus* species-group. As Lynch and Duellman did not examine the types, we offer the following observations.

Both types are faded such that most features of any color patterns are no longer discernible. The lectotype is in poor condition, the paralectotype is in worse condition. The paralectotype is very brittle and fragile and disintegrates more each time it is handled. The lectotype is the (noticeably) larger of the two, and the only specimen measured for purposes of this paper. WRH recorded the measurements (in mm) of the lectotype as: SVL 24.6 (contrasted to Mi-

randa-Ribeiro’s measurement of 27); head length 8.6; head width 8.5; eye–nostril distance 3.5; eye–eye distance 5.1; greatest tympanum diameter 2.4; thigh 13.9; shank 14.1; foot 12.0; width of 3rd finger disk 1.4; width of 4th toe disk 0.7. The lectotype has slits in the floor of the mouth, but they appear to be cuts, not vocal slits. The sex of the lectotype can not be determined with certainty without dissection, which given the poor condition of the specimen was considered inappropriate.

The following support recognition of *Tetlatrema heterodactylum* as a distinct and valid species of *Eleutherodactylus*, confirming Lynch & Duellmans’ (1997) assessment.

The disks on fingers 3 and 4 are very large, much larger than the disk on the fourth toe, and the shape is ovate (Fig. 4a). The disks on fingers 3 and 4 of the other *Eleutherodactylus* examined are expanded, but either the same size or just larger than

Table 7.—Posterior face of thigh patterns. Locality numbers refer to those in Fig. 2 (9a not mappable). A = Uniform; B = Finely mottled around vent, rest uniform; C = Finely mottled; D = Mottled. Data are number of individuals demonstrating the various states.

Taxa Locality	<i>E. heterodactylus</i> 1	<i>E. crepitans</i> 2	C. dos Guimarães 3	?	?	?	<i>E. fenestratus</i>					
							7	8	9	9a	10	Peru
A	2		7	2			3	7	18		20	5
B		3	3					1	3	1	1	8
C			1									15
D					1	1						



Table 8.—Belly patterns. Locality numbers refer to those in Fig. 2 (9a not mappable). A = Almost immaculate; B = Noticeably flecked or mottled. Data are number of individuals demonstrating the states. Specimen from locality 6 too faded to score.

Taxa Locality	<i>E. heterodactylus</i> 1	<i>E. crepitans</i> 2	C. dos Guimarães 3	? 4	? 5	? 6	<i>E. fenestratus</i>					Peru
							7	8	9	9a	10	
A	1	3	10	2	1		6	10		11	28	
B			1				3	2	11	1	10	

the disks on toe 4 and they are broadly triangular in shape (Fig. 4b, c).

The type illustrations (most likely that of the lectotype, Miranda-Ribeiro 1937, Fig. 2a–b) show a pair of ill-defined light longitudinal stripes from behind the eye to the sacrum. This feature is not seen in any of the other *Eleutherodactylus* examined for this study.

The type locality is characterized by a very open vegetation formation lacking gallery forests. *Eleutherodactylus fenestratus* is a forest denizen and the Chapada dos Guimarães form inhabits well-developed gallery forests. *Eleutherodactylus crepitans* also occurs in open habitats, but is morphologically very distinct from *E. heterodactylus*.

One other morphological feature will require fresh material to evaluate. There is no indication of any tarsal fold or other tarsal decoration on either the lectotype or paralectotype, suggesting that, if in fact the tarsus lacks a fold, that would be another feature distinguishing the species from all other Mato Grosso *Eleutherodactylus*.

*Eleutherodactylus heterodactylus* (Miranda-Ribeiro 1937) is thus far known only from the original two specimens collected by Miranda-Ribeiro from “Fazendinha.” All other members of the *Eleutherodactylus binotatus* group, to which Lynch & Duellman (1997) assigned *E. heterodactylus*, occur in eastern Brazil, primarily in the Atlantic Forest Morphoclimatic Domain. Inclusion of *E. heterodactylus* in this group does not make zoogeographic sense.

*Status of Eleutherodactylus crepitans Bokermann, 1965.*—Werner C. A. Bokermann described the species based on three specimens from São Vicente, Mato Grosso. The holotype and allotype are now in the collections of the Museu de Zoologia, Universidade de São Paulo and the other paratype is in the Museu Nacional, Rio de Janeiro.

John Lynch (1980:8) synonymized *Eleutherodactylus crepitans* Bokermann, 1965 with *E. fenestratus* (Steindachner 1864). Lynch did not examine the specimens of *E. crepitans* (1980:6). Lynch argued that because Bokermann was unaware

Table 9.—Tarsal fold states. Locality numbers refer to those in Fig. 2 (9a not mappable). A = Absent; B = Short, oblique, lying more than length of inner metatarsal tubercle from inner metatarsal tubercle; C = Moderately short, less than ½ length of tarsus, lying less than length of inner metatarsal tubercle from inner metatarsal tubercle; D = Long, greater than ½ length of tarsus, lying less than length of inner metatarsal tubercle from inner metatarsal tubercle. Data are number of individuals demonstrating the various states. Data not taken for one desiccated individual from locality 10.

Taxa Locality	<i>E. heterodactylus</i> 1	<i>E. crepitans</i> 2	C. dos Guimarães 3	? 4	? 5	? 6	<i>E. fenestratus</i>					Peru
							7	8	9	9a	10	
A	1	1									1	
B		2										
C			10	2	1	1	3	8	21	1	19	28
D			1			1						





Table 12.—Adult size. Locality numbers refer to those in Fig. 2 (9a not mappable). Data are SVL ranges in mm.

Taxa Locality	<i>E. heterodactylus</i>		C. dos Guimarães			<i>E. fenestratus</i>						
	1	2	3	4	5	6	7	8	9	9a	10	Peru
Females		30	34–36			34	38–41		37–40	42	37–44	40–52
Males		28–29	22–27		30				30		26–32	27–34
Largest juveniles	25			30				29				

name *Hylodes gollmeri bisignata* Werner, 1899, which based on geography should be considered as an available name for the frogs considered in this paper, and specimens of *Eleutherodactylus* from three localities in Mato Grosso can not be unequivocally assigned to either *Eleutherodactylus crepitans*, *fenestratus*, *heterodactylus*, or the Chapada dos Guimarães form. Advertisement calls are not available at present for any of the specimens involved. At this time, they are best left as indeterminate.

Werner (1899) gave a brief description of *Hylodes gollmeri bisignata* without locality information in the type description. Häupl & Tiedemann (1978) indicated that the holotype, NMW 16502, in the Naturhistorischen Museums Wien collection was from Chaco, Bolivia. Lynch & Duellman (1997) considered *bisignatus* to be a synonym of *Eleutherodactylus fenestratus*. Based on the fact that the Chaco and Amazonian hylaea frog faunas are virtually distinct from each other at the species level, the validity of *E. bisignatus* should be reconsidered. The original description is too brief to be of help in evaluating this suggestion. Dr. Lynch examined the type of *H. g. bisignata*, but his original notes are not in the appropriate folder in his archives (pers. comm.). The Naturhistorisches Museum Wien now has a policy of not loaning types, precluding our examination of the type for this paper. We suspect that *bisignatus* is a species of *Eleutherodactylus* distinct from *E. fenestratus*. If it is the same as any species that occurs in Mato Grosso, it might be conspecific with *E. heterodactylus*, based on most similar (but still quite different) habitat occurrences.

The two specimens from the Panatanal locality of Fazenda do Santa Edwiges (Fig. 2, Locality 4) could either be the same as the Chapada dos Guimarães form or a distinct species. The smaller specimen (MZUSP 71103) has a tarsal fold like that of the Chapada dos Guimarães form, but the larger specimen (MZUSP 71104, which looks like it died before it was preserved) appears to have a much longer tarsal fold.

The single specimen from Jacobim (MZUSP 4277) has completely mottled thighs with a large pattern, such that the white blotches almost cover the same total area as the darker ground hue. The thigh pattern differs markedly from other specimens discussed in this paper, but is closer to that of specimens identified as *Eleutherodactylus cf. peruvianus* (e.g., MZUSP 80854, 80856–80857, 80859, 80863) from the Amazon forest locality of Apiacás. Jacobim, however, is in an area of Cerrado-seasonal forest contact (Fig. 2, Locality 5).

The two specimens from Barra do Tapi-rapés are very faded and their proper taxonomic allocation may never be ascertained until fresh specimens from the locality are available. The fading extends to the posterior surfaces of the thighs, but it does appear that the thighs are mottled in a similar fashion to the pattern observed in MZUSP 4277 from Jacobim, with which they may be conspecific.

*Status of the Chapada dos Guimarães form.*—As documented above, the Chapada dos Guimarães *Eleutherodactylus* represents a distinct species from all other known *Eleutherodactylus*, which we describe as:

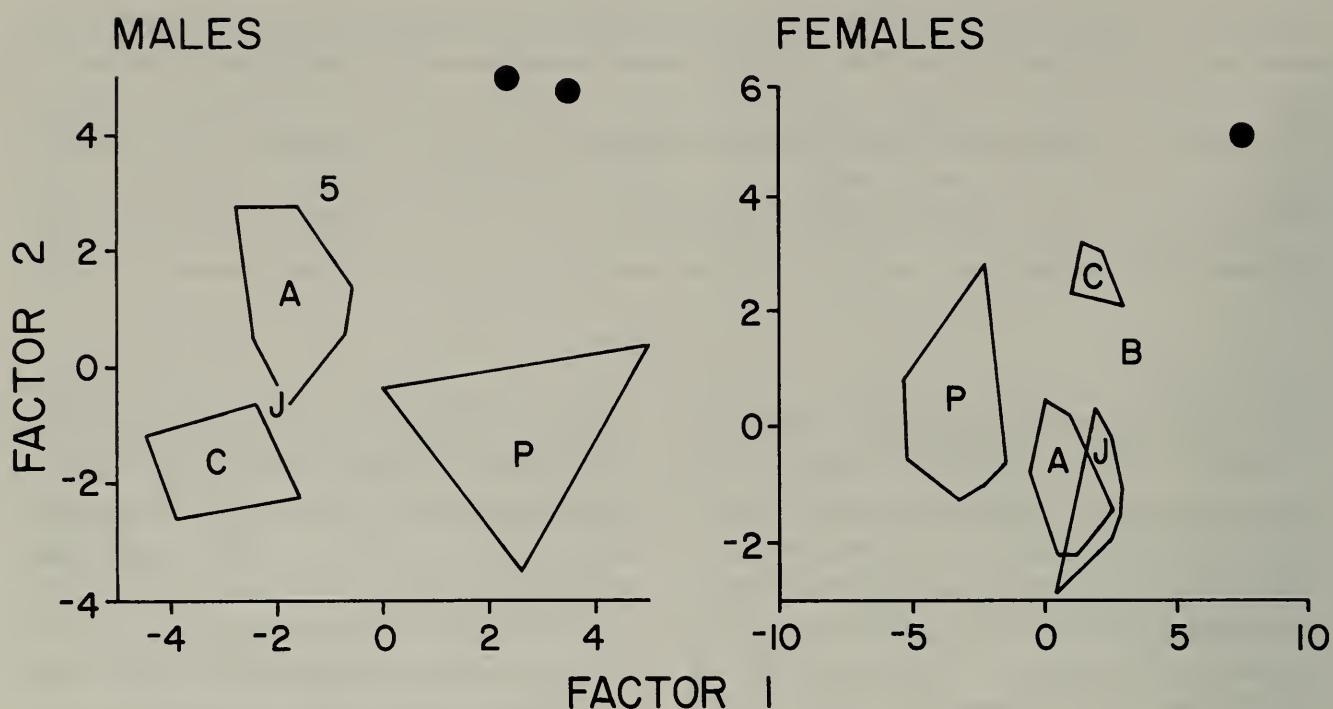


Fig. 3. Discriminant function analysis results for males and females. Minimum polygons contain all individuals for sample sizes  $>3$ . Dots = *Eleutherodactylus crepitans*; A = sample from Aripuanã, Mato Grosso; B = individual from Barra do Tapirapés, Mato Grosso; C = sample from Chapada dos Guimarães, Mato Grosso; J = individual (male) and sample (females) from Juruena, Mato Grosso; P = sample from Peru; 5 = individual from Jacubim, Mato Grosso.

*Eleutherodactylus dundeei*,  
new species  
Figs. 1b, 5

*Holotype*.—MZUSP 79834, adult male from Brazil: Mato Grosso; Chapada dos Guimarães, Veú da Noiva, Rio Coxipozinho, approximately  $15^{\circ}25'S$ ,  $55^{\circ}47'W$ . Collected by Miriam H. Heyer, W. Ronald Heyer, and Liliam Patricia Pinto on 25 Sep 1996.

*Paratopotypes*.—MZUSP 79835–79837 (1 female, 2 males), same data as holotype.

*Paratypes*.—All from Brazil: Mato Gros-

so; Chapada dos Guimarães; MNRJ 19785 (female), collected by Ermínia (UFF) on 24 Oct 1987; MZUSP 76237 (juvenile), an originally unnumbered specimen from the Werner C. A. Bokermann collection collected by A. Sebben and A. Schwartz on 15 Jun 1988; MZUSP 85614 (male), originally WCAB 15546 collected by M. Alvarenga, F. M. Oliveira, and Werner C. A. Bokermann from 15–25 Nov 1963; USNM 507897–507898 (female, male), Casa de Pedra, collected by Miriam H. Heyer, W. Ronald Heyer, Liliam Patricia Pinto on 28 Sep 1996; USNM 507899 (male, call voucher for Fig. 1b), Estancia Monarca, collected by Miriam H. Heyer, W. Ronald Heyer, Liliam Patricia Pinto on 30 Sep 1996; USNM 507900 (female), Escola Evangelica de Buriti, collected by Miriam H. Heyer, W. Ronald Heyer, Liliam Patricia Pinto on 1 Oct 1996.

*Diagnostic definition* (scheme established by Lynch, e.g., 1979, of numbered character states followed here for ease of comparison).—Skin of upper surfaces finely

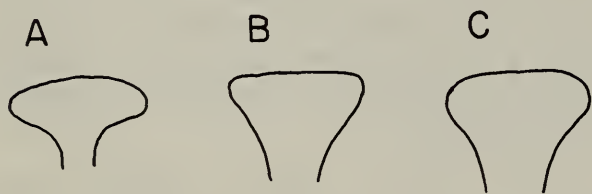


Fig. 4. Diagrammatic outlines of shape of third finger disk based on free-hand sketches. A. Holotype of *Telatrema heterodactylum*, actual width of disk 1.4 mm. B. Holotype of *Eleutherodactylus crepitans*, actual width 0.9 mm. C. Chapada dos Guimarães form, actual width 1.3 mm (based on USNM 507897).



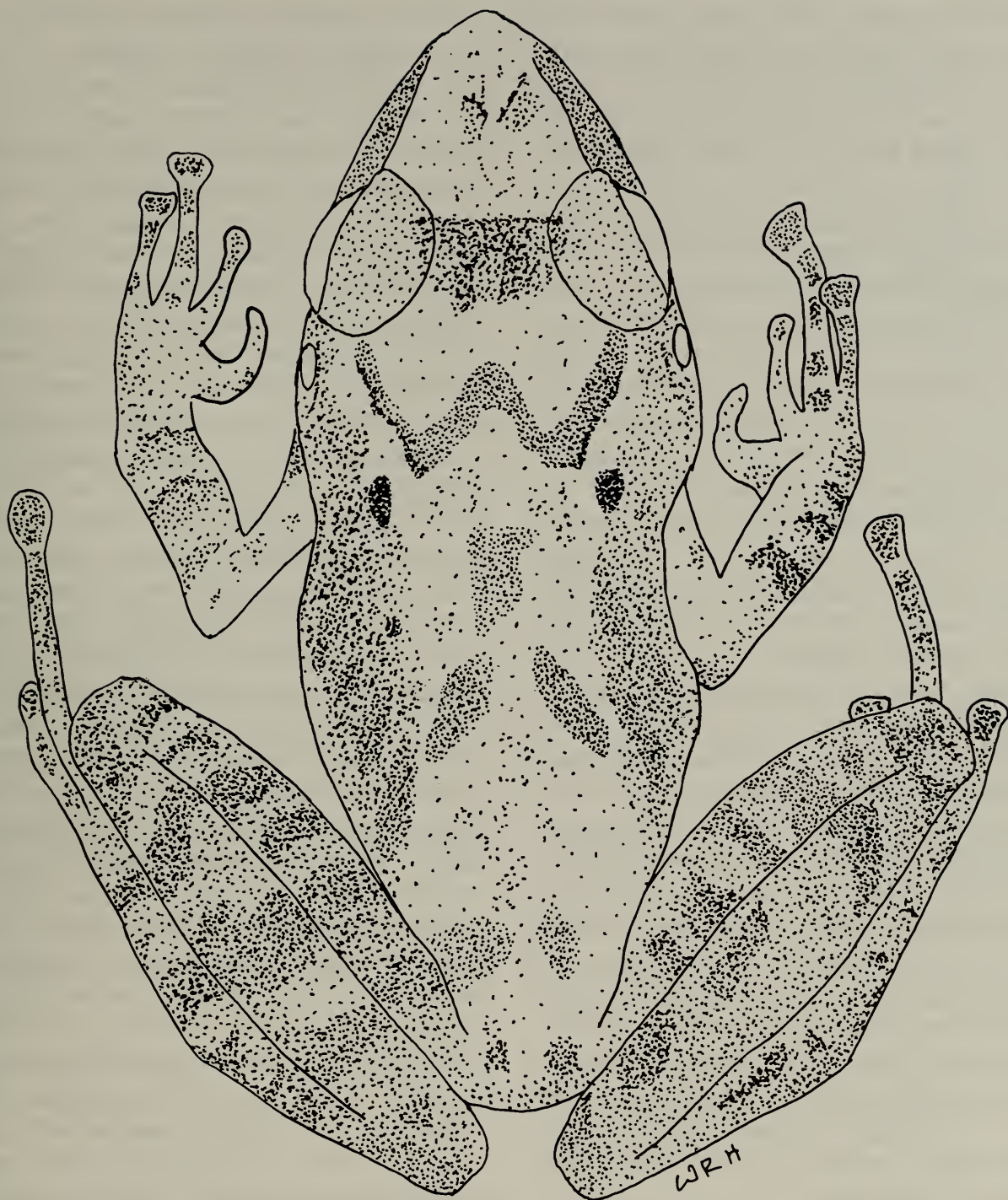


Fig. 5. Dorsal view of paratype of *Eleutherodactylus dundeei*, new species, USNM 507899. This specimen has the most contrasting pattern among the type series. Other specimens have similar, but fainter markings.

pebbled with few to many scattered white fleshy tubercles, tubercles denser posteriorly, skin of throat, chest, and anteriormost belly smooth, rest of belly weakly areolate; tympanum distinct, its horizontal diameter about  $\frac{1}{2}$ – $\frac{3}{5}$  eye opening diameter; snout subelliptical in dorsal view, rounded in profile; upper eyelid width equal to or (usually) slightly smaller than interorbital distance,

with same fine pebbling of back with scattered, low, flattened, light tubercles; no cranial crests; vomerine teeth in two small patches well posterior to choanae, separated from each other by about the width of a single tooth patch; males with vocal slits and single subgular vocal sac, either noticeably expanded and wrinkled in preservation or not; male nuptial pads of two weak light

glandular patches; first finger about same size or just longer than second; fingers bearing disks (largest on III and IV); largest disks broader than long; fingers free or with weak lateral keels; 2–7 light spots indicating weakly developed ulnar tubercles (tubercles themselves visible in only some individuals); short tarsal fold, about  $\frac{1}{3}$  length of tarsus, otherwise tarsus smooth; heel smooth to granular, lacking tubercle(s); 2 metatarsal tubercles, inner oval, 2–3 times size of outer; 0–2 fleshy plantar tubercles; toes free or (usually) bearing weakly to well developed lateral keels; individuals with well-developed keels with basal toe webbing; predominantly brown frog, no flash colors; posterior surfaces of thighs flesh color-purplish in life, tan/brown in preservative; adults small, males 22–27 mm, females 34–36 mm SVL.

*Eleutherodactylus dundeei* is most similar to and most likely to be confused with *Eleutherodactylus fenestratus*. *Eleutherodactylus dundeei* is smaller (males 22–27 mm, females 34–36 mm SVL) than *E. fenestratus* (males 26–34 mm, females 37–52 mm SVL). The belly of *E. fenestratus* is either entirely smooth; or weakly areolate only on the lateralmost portions, but not areolate posteriorly; the belly of *E. dundeei* is weakly areolate at least posteriorly. Male *E. dundeei* have two weakly developed light glandular nuptial asperities on each thumb; male *E. fenestratus* have a single, better developed light glandular nuptial asperity on each thumb.

*Description of holotype*.—Snout shape subelliptical in dorsal outline, rounded in profile; canthus rostralis sharply rounded; lip weakly flared; upper eyelid width about equal interocular distance; no external indications of cranial crests; tympanum distinct, horizontal diameter including annulus about  $\frac{1}{2}$  eye opening diameter, horizontal diameter < vertical diameter; vomerine teeth in two small patches, well posterior to rounded choanae, separated from each other by about width of a single tooth patch; vocal slits present, elongate; vocal sac single,

subgular, slightly expanded externally in preservation; finger lengths I just >II<IV<III (left finger IV mostly missing); finger tips on fingers I and II slightly expanded, small, round, lacking circumferential grooves, fingers III and IV with expanded disks, triangular, broader than long, with circumferential groove and upper surface weakly to noticeably notched; fingers lacking noticeable lateral keels; no finger webbing; palmar tubercle large, ovate-heart-shaped, larger than proximate ovoid thenar tubercle, one well-developed supernumerary palmar tubercle associated with each digit; subarticular tubercles distinct, rounded, single, each thumb with 2 weakly developed but distinct patches of light glandular nuptial excrencences; outer ulnar region with a series of 6–7 light spots, apparently with low tubercles in life, but only one weakly visible on each arm; supratympanic fold distinct; no other distinct glands or folds on body; upper eyelid weakly pebbled with several light tubercles, rest of back texture weakly pebbled with scattered light fleshy tubercles; throat smooth, discoidal belly fold distinct, chest and adjoining belly to about mid-belly smooth, sides of and posterior belly weakly areolate, ventro-posterior surfaces of thighs areolate, rest of ventral limb surfaces smooth; toe lengths I<II $\approx$ III<V<IV (condition B as used in Lynch & Duellman 1997, appendix III); disks on toes I and V small, round, disks on toes II, III, IV increasing in size, largest disks triangularly ovate, broader than long, upper surfaces emarginate or weakly notched; sides of toes keeled, strongest on inner sides of toes II, III, IV, forming basal web, not encompassing the basal subarticular tubercles, best developed between toes II, III, IV; outer round metatarsal tubercle about  $\frac{1}{4}$  size of ovate inner metatarsal tubercle; tarsal fold distinct, short, about  $\frac{1}{4}$  length of tarsus, separated from inner metatarsal tubercle by a distance of about  $\frac{1}{2}$  length of tarsal fold, rest of outer tarsus smooth; heel smooth, lacking tubercle(s) or calcar; plantar surface with one prominent



fleshy tubercle; subarticular tubercles moderately developed, weakly pungent.

Coloration in alcohol: A tan frog with brown markings. Tip of snout lightest, expanding into somewhat darker but light triangle bounded by canthus rostralis and dark interorbital mark, with a few brown dots and lines. Dark canthal stripe in front of eye only extending about  $\frac{1}{4}$  distance to nostril. Loreal region almost uniform brown. Upper lip indistinctly barred. Supratympanic fold dark brown. Faint interorbital bar, defined by straight solid brown line anteriorly, very weakly defined posteriorly as a shallow U with a few dark dots in the interorbital mark. A faint dark W-shaped mark in the pre-scapular area followed by a median, faint, inverted Y-shaped mark between scapular and sacral region, followed by two median irregular sacral chevrons. Noticeably dark pair of lateral spots behind eyes in scapular region. Upper limbs tan with irregular darker cross bands. Series of 6–7 light spots on outer ulnar region. Throat speckled with melanophores. Chest and belly light, almost immaculate, but with a very few scattered melanophores. Posterior surfaces of thighs with very fine mottle pattern on area just around vent, otherwise uniform tan. Outer tarsus and sole of foot dark brown.

*Measurements of holotype.*—SVL 23.6 mm, head length 9.6 mm, head width 7.9 mm, eye opening diameter 3.0 mm, eye–nostril distance 3.0 mm, eye–eye distance 4.9 mm, horizontal tympanum diameter 1.8 mm, vertical tympanum diameter 1.9 mm, thigh length 11.6 mm, shank length 13.3 mm, foot length 11.7 mm, width of 3rd finger disk 1.0 mm, width of 4th toe disk 0.7 mm.

*Variation.*—Most details of variation have been described in the preceding sections. Additional measurement variations are (broken down by sex only when range of one not subsumed in other): head length 39–42% SVL; head width 33–38% SVL; eye–nostril distance 12–14% SVL; eye–eye distance 20–22% SVL for males, 18–19%

for females; tympanum diameter 7–9% SVL; thigh length 48–53% SVL; shank length 52–57% SVL; foot length 47–54% SVL for males, 46–53% for females; width of 3rd finger disk 3–4% SVL; width of 4th toe disk 3–4% SVL.

*Color in life.*—Iris bright bronze above, dull bronze below; posterior face of thigh flesh color-purplish; belly white with yellow wash; no flash colors (based on USNM 507897–507898).

*Advertisement call.*—Described in previous section (Fig. 1b).

*Etymology.*—Named for Dr. Harold A. Dundee for his personal, financial, and scientific contributions to the field of herpetology.

*Ecological notes.*—Data are available for eight individuals. Five of them were collected in the late morning on dead leaves or under 5 cm diameter rocks on the ground, four of these 3–6 m from a river bank in rainforest-like gallery forest (MZUSP 79834–79837), one of these on dead leaves on the ground on the bank of a tree-shaded pond (USNM 507900). Two individuals were taken shortly after dark in cerrado gallery forest 2 m from a 2 m wide stream either on the surface of the soil (USNM 507897) or on a 0.3 m diameter log (USNM 507898). The call voucher (USNM 507899) was taken at night from secondary cerrado vegetation on a leaf of a herbaceous plant, less than 1 m above ground.

*Distribution.*—All known specimens have been collected from within 25 km of the town of Chapada dos Guimarães in the limited region identified as having mesophilic seasonal forest vegetation cover in the Cartograma de Vegetação do Estado de Mato Grosso, produced by the Consórcio Nacional de Engenheiros Consultores S.A., published by the Governo do Estado de Mato Grosso (Fig. 6). There are other islands of similar vegetation cover in the same region (Fig. 6) which might be expected to contain *Eleutherodactylus dundeei*. We predict that either *E. dundeei* is restricted to the known Chapada dos Gui-



Fig. 6. Major vegetation types in portion of the State of Mato Grosso surrounding Chapada dos Guimarães. Black areas are mesophilic seasonal forests. Stippled areas are dense cerrado (cerradão) and forest/cerrado contact regions. Rest of region is covered by various forms of cerrado vegetation (except cerradão). Open square is the city of Cuiabá.

*Eleutherodactylus dundeei* is thus far only known from the mesophilic seasonal forest block identified as 3 on the map, but other nearby blocks should be explored for the species. Map redrawn from "Cartograma de Vegetação do Estado do Mato Grosso," produced by Consórcio Nacional de Engenheiros Consultores S.A.

marães vegetation type block or to it and one or more of the additional habitat islands identified in Fig. 6.

### Discussion

*Eleutherodactylus fenestratus*, with the removal of *Eleutherodactylus crepitans* and *dundeei*, has an Amazonian rainforest distribution (assuming *Eleutherodactylus bisignatus* is not a synonym of *E. fenestratus*). There has not been an adequate study of variation for *E. fenestratus*. The limited data we analyzed indicate that there is at least interpopulational variation in *E. fenestratus*. Analyzing variation throughout the entire range of the species would be an ob-

vious next step to understand the significance of the variation we found.

Chapada dos Guimarães has a very interesting frog fauna from a zoogeographical perspective. The landscape surrounding the Chapada is cerrado. There are expected cerrado frog species at Chapada dos Guimarães, such as *Bufo paracnemis*, *Scinax fuscovarius*, *Leptodactylus labyrinthicus*, and *Physalaemus nattereri*. There are also Chaco and Amazonian elements represented. For example, the Chaco species *Leptodactylus chaquensis* was collected syntopically with the Amazonian species *Leptodactylus mystaceus* in 1996. Finally, there are at least two species thus far known only from Chapada dos Guimarães, *Phyllomedusa cen-*



*tralis* Bokermann, 1965 and *Eleutherodactylus dundeei*. Obviously, the frog fauna of Chapada dos Guimarães represents a rich and complicated history, worthy of much more detailed study. There is actually a fair amount of information available for frogs from Chapada dos Guimarães to base such a study upon. Herbert Huntingdon Smith collected materials reported on by E. D. Cope (1887) and housed at the Academy of Natural Sciences in Philadelphia. At least one of the species reported, *Leptodactylus petersii*, has not been collected since from Chapada dos Guimarães (Heyer 1994:79, Cope's *Leptodactylus brevipes* = *L. petersii*). Boulenger (1903) listed nine species collected by the Percy Sladen Expedition to central Brazil. The species Boulenger listed as *Hylodes gollmeri* is probably the species we describe as *Eleutherodactylus dundeei*. All other species of Boulenger's list are plausible (with taxonomic adjustments) except for *Ceratophrys cristiceps*, which should be re-examined. Werner C. A. Bokermann and colleagues made collections which now (for the most part) are at MZUSP. MZUSP also has materials collected by Drs. Rita Kloss and Francisca C. do Val. Adão Cardoso also collected at Chapada dos Guimarães, and those specimens are housed at the Universidade Estadual de São Paulo in Campinas. As Chapada dos Guimarães is now a tourist attraction, it is likely that there are other incidental collections waiting study in various collections as well.

#### Acknowledgments

PRODEAGRO and CENEC made the fieldwork possible during which the recordings of *Eleutherodactylus dundeei* were obtained. Without these recordings, this paper would not have been initiated. Drs. John D. Lynch and P. E. Vanzolini critically reviewed the manuscript. AMM thanks the National Museum of Natural History for the opportunity to participate in the 1997 Research Training Program. WRH thanks

Dr. P. E. Vanzolini and the Museu de Zoologia da Universidade de São Paulo for characteristic help and access to the collections. Dr. Ulisses Caramaschi facilitated examination of specimens in the collections of the Museu Nacional, Rio de Janeiro. WRH's research for this paper was supported by the Neotropical Lowlands Research Program, National Museum of Natural History, Dr. Richard P. Vari, Principal Investigator.

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## Appendix 1

## Specimens examined

*Eleutherodactylus crepitans*.—Brazil: Mato Grosso; São Vicente, 15°38'S, 55°23'W, MNRJ 3985 (paratype), MZUSP 73671 (allotype), 85628 (holotype).

*Eleutherodactylus dundeei*.—See species account.

*Eleutherodactylus fenestratus*.—Brazil: Mato Grosso; [Alto Juruena—see preceding Juruena], Apicás, 09°34'S, 57°23'W, MZUSP 80851–80853, 80855, 80858, 80860–80862; Aripuanã, 10°24'S, 59°19'W, MZUSP 80643–80648, 80652–80654, 86410; Alto Juruena (locality is the upper Rio Juruena and cannot be assigned specific coordinates), MZUSP 85540; Juruena, 10°18'S, 58°32'W, MZUSP 86153–86200; São José do Rio Claro, 13°26'S, 56°44'W, MZUSP 86358–86360.

Peru: Madre de Dios; Pakitza, 11°58'S, 71°14'W, USNM 333014, 342618–342622, 342851–342853, 345172; Tambopata, 12°50'S, 69°17'W, USNM 222268, 247298–247304, 247630–247631, 268941–268944, 314901, 332438–332439, 342993.

*Eleutherodactylus heterodactylus*.—Brazil: Mato Grosso; Fazendinha, near Pirizal, 16°00'S, 57°36'W, MNRJ 106 (lectotype), 5089 (paralectotype).

*Eleutherodactylus* sp.—Brazil: Mato Grosso, Barra do Tapirapés, 10°39'S, 50°36'W, MZUSP 85645–85646; Jacubim, 13°20'S, 52°09'W, MZUSP 4277; Fazenda Santa Edwiges, 16°38'S, 55°11'W, MZUSP 71103–71104.